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METALLURGICAL BROWNFIELDS RE-USE IN THE CONDITIONS OF SLOVAKIA – A CASE STUDY

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The article deals with a system approach to solving the problems of re-use of metallurgical brownfields in Slovakia, as a potential tool to support further regional development, accepting the valid legal regulations of the Slovak Republic, as well as the principles of sustainable environmental development. The solution to this problem was based on the identification of the specific aspects of the benefits and risks of internal and external environment determining the resulting benefit from the realisation of potential metallurgical brownfields development projects and monitoring of selected indicators supporting the development of the region itself.

Key words: metallurgical brownfield, management system, re-use, regional development, Slovakia

INTRODUCTION

Metallurgical brownfields represent a hidden reserve to the development of the Slovak economy, which can be understood as a potential tool for further development of individual regions. Their development suggest strong inter-regional disparities not only in socio-economic but also in the environmental field.

So far, in Slovakia the issues related to further development of metallurgical brownfield are addressed separately but only marginally under other sectoral operational programs since their formation is associated with restructuring of the Slovak economy and subsequent attenuation of metallurgical production, characterized by specificities stemming from metallurgical production processes associated with production quantities of pollutants from many of which are toxic or with other negative effects (carcinogenic, mutagenic, teratogenic etc.). Therefore intervention by the state (both cash and non-cash forms) must be used to support their intensive development in further development whose solution requires the development of an individual and coherent strategy based on a system of management of their revitalization and subsequent use under well defined conditions and other necessary formalities through legislative measures.

THEORETICAL

In Slovakia typical metallurgical brownfields accompanied by an environmental burden and in many cases also by the risk of accidents include the area of former nickel smelter in the city of Sered', aluminium plant in the city of Žiar nad Hronom, metallurgical plant Kovohuty Krompachy, plant producing antimony in the village of Vajsková, plant producing pig iron in in the city of Hnúšťa, plant producing ferroalloys in the city of Istebné [1, 2].

Completed projects of revitalization and re-use of metallurgical brownfields contributed to elimination of threats connected with elimination of the associated costs incurred in territories without benefit, increase of the environmental quality, reduction of the rate of registered unemployment, increase of the purchasing power, gain of new opportunities for development of the region [3].

The problem of metallurgical brownfields requires a systemic approach to define the management of their recovery and further development accepting the principles of sustainable development and environmental anthropogenic society which integrates the potential risks associated with complex process of metallurgical brownfields regeneration that arise from financial costs of removing the contaminated sites creating a barrier to their re-use [4].

MODEL OF METALLURGICAL BROWNFIELD REVITALIZATION

Explicit identification of the benefits and risks, their interactions, in implementation of metallurgical brownfield regeneration projects is a fundamental area of investigation necessary for their implementation in context of regional development in Slovakia. In the existing development of addressing metallurgical brownfields issue 7 essential factors in benefits (Table 1) were identified. Based on mutual comparison of their interactions partial recovery efficiencies in relation to the development of metallurgical brownfield hence the region concerned were established. The interaction was based on the attri-

S. Khouri, H. Pavolová, M. Cehlár, T. Bakalár, Technical University of Košice, Faculty of Mining, Ecology, Process Control and geotechnologies, Košice, Slovakia

bution of weights 1, 0, or 0,5. A value of 1 indicates a significantly higher importance factor evaluated from comparison, the value 0 at significantly lower importance and value of 0,5 points on the equal importance of both factors in metallurgical process of regeneration of brownfield sites in context of regional development.

The matrix of benefits (Table 1) implies that the redevelopment of devastated buildings is of the highest priority and innovativeness of the completed project further is of the lowest priority in the metallurgical brownfield regeneration process in the context of promoting further regional development.

Table 1 **Matrix of metallurgical brownfields revitalisation benefits**

Factor / interact-ion	A	B	C	D	E	F	G	Σ	W / %
Cost of brown invest-ment (A)	X	0	0	½	1	0	½	2	9,5
Economic benefits (B)	1	X	½	½	1	½	½	4	19,1
Environ-mental benefit (C)	1	½	X	½	1	½	½	4	19,1
Reducing unemploy-ment (D)	½	½	½	X	1	0	½	3	14,3
Innova-tiveness of the Project (E)	0	0	0	0	X	0	½	½	2,4
Brown-field objects re-develop-ment (F)	1	½	½	1	1	X	1	5	23,8
Support of regional develop-ment (G)	½	½	½	½	½	0	X	2½	11,9

Key: W – Weight

It can only be identified 5 risk factors within the matrix by the same methodological approach as the already mentioned benefits. The result thus highlighted the importance of risk factors affecting the implementation of metallurgical brownfields regeneration projects in relation to regional development. The most significant risk for the successful implementation of a comprehensive recovery plan is the insolvency of the investor (Table 2), which may occur for example by additional costs associated with removing environmental burden occurring in the territory of the brownfield resulting from previous metallurgical activities.

The development of metallurgical brownfields by running projects of revitalisation and subsequent re-use is determined by the willingness of potential investors to create so-called brown investment. Therefore, it is necessary to synthesize the results of the above matrices of benefits and risks of metallurgical brownfields revitalisation into a comprehensive indicator in the form of so called "scoring ratio" which would at least point out the suitability of such investments. The scoring ratio, which is proposed on the basis of summarizing the ratios of positive and negative factors of project implementation, predicts a specific category of designation of a metallurgical brownfield project pointing to the ultimate benefit of investment in the project, i.e. the ultimate effect of brown investment.

The matrix (Table 3) providing a comprehensive assessment of the further development of a metallurgical brownfield clearly shows the predominance of the benefits (67,741 %) over the risks (32,259 %) with a scoring ratio of 2,0999 which indicates the suitability of this type of brown investment by inclusion into the II. category "Highly Effective" (Table 4).

Table 2 **Matrix of risks of metallurgical brownfields revitalisation**

Factor / interaction	(A)	(B)	(C)	(D)	(E)	Σ	W / %
Competition of greenfields (A)	X	0	½	½	0	1	10
Environme-ntal burden (B)	1	X	½	½	0	2	20
Low return on brown invest-ment (C)	½	½	X	1	½	2½	25
Lack of support programs (D)	½	½	0	X	0	1	10
Insolvency of the investor (E)	1	1	½	1	X	3½	35

Key: W – Weight

Table 3 **Matrix of comprehensive evaluation**

Factor		Score / %	Overall score / %	Scoring ratio
Cost of brown investment	+	6,452	67,741	2,0999
Economic benefits	+	12,903		
Environmental benefit	+	12,903		
Reducing unemployment	+	9,677		
Innovativeness of the project	+	1,613		
Brownfield objects redevelop-ment	+	16,129		
Support for regional develop-ment	+	8,064		
Competition of greenfields	-	3,226	32,259	
Environmental burden	-	6,452		
Low return on brown invest-ment	-	8,065		
Lack of support programs	-	3,226		
Insolvency of the investor	-	11,29		

DRAFT OF THE MODEL OF MANAGEMENT

Effective management of projects for further develop of metallurgical brownfields must comply with all specifications of solved metallurgical brownfield stemming from particular species and nature of the metallurgical production, i.e. from inputs, the transformation process and the actual outcomes including produced slag, waste containing hazardous substances of toxic, carcinogenic, mutagenic, or teratogenic nature, taking into account their synergistic effects and transmission in the environment that are in most cases environmental burdens. Moreover, following the understanding of the management system, it is necessary to take into account the degree of devastation of production and non-production objects, and their material composition and structures of other building segments which also significantly affect the total cost of brown investment revitalization and subsequent utilisation of metallurgical brownfields. A significant aspect directly influencing the implementation of a particular project is also the actual location, the availability of foreign cash funds (bank loans, EU funds), various forms of support programs (cash and non-cash) and their overall economic and environmental benefits.

Table 4 **Categorization of projects**

Category of metallurgical brownfield project		Scoring ratio
I. category	Very high efficiency	> 2,33
II. category	High efficiency	2,32 to 1,85
III. category	Average efficiency	1,84 to 1,50
IV. category	Low efficiency	1,49 to 1,22
V. category	Very low efficiency	1,21 to 1,00
VI. category	Ineffective	≤ 0,99

The proposed model of effective management system for further development of metallurgical brownfields respects all external and internal factors directly influencing the course of the revitalization project implementation process and subsequent specific utilisation of metallurgical brownfields and determining benefits based on final comparative synthesis of the results of benefits and risks matrixes with the integrated indicator of the estimated result in the form of "scoring ratio" as stated in the flowchart of management for further development of metallurgical brownfields (Figure 1).

CONCLUSION

The actual developments of addressing brownfields in general which recovery is complicated by unclear property rights, lack of information on the kind and extent of contamination determining the economic risks associated with revitalisation and the resulting additional liabilities. They point to the fact that these areas are not only an isolated problem of the industry but also a problem which solving strategy could be the responsibility of one ministry. Support programs addressing this issue should be in direct relation to the assessment of environmental burdens which are additional expenses on implementation of projects for further development and therefore a significant risk to the investor from the view of non-existent possibility of quantification of input costs, which may ultimately lead to negative economic effect of the brown investment.

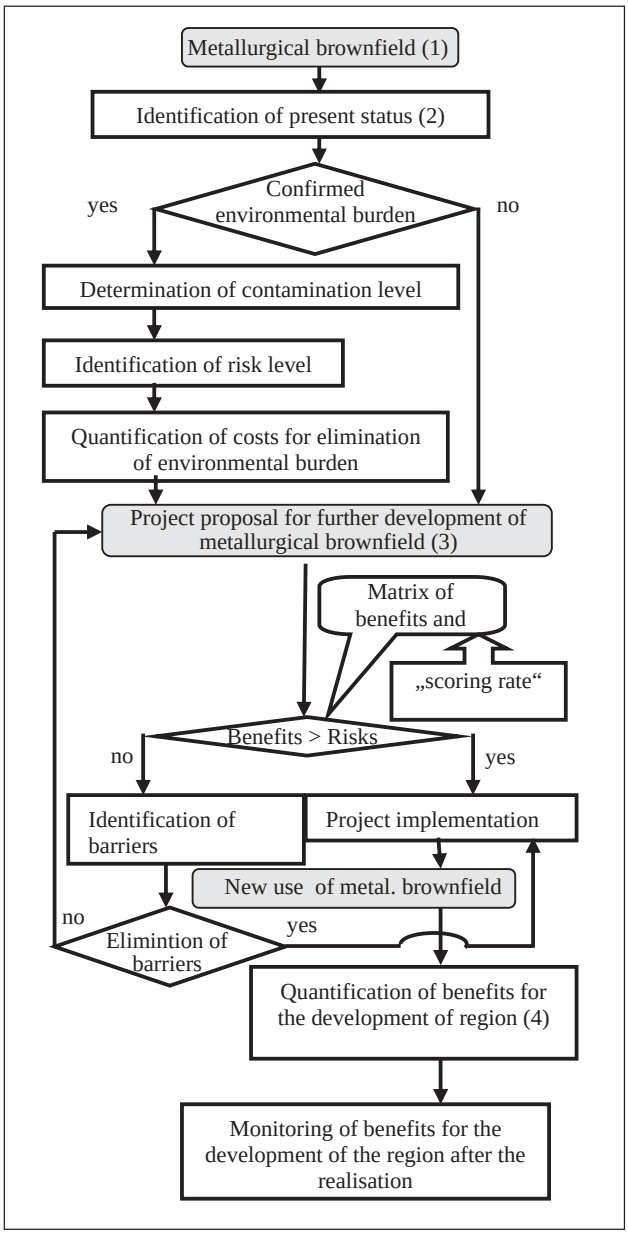

Figure 1 Model of the management system for further development of metallurgical brownfields

Notes to Figure 1:

(1) - the region of incident
- social and economic indicators of region
- environmental quality in the region
- connection to roads
- proximity of the railway line

(2) - devastation of production and non-production objects
- level of connection to the water supply and sewerage
- level of connection to the energy structure
- level of connection to roads
- proximity of the railway line

(3) Economic, social, legislative, political factors influencing the further development of metallurgical brownfield

(4) - newly created indirect jobs
- amount of social contributions
- amount of health insurance contributions
- amount of tax contribution
- environmental benefits, etc.

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Note: The person responsible for English is Martina Pľuchtová (Technical University of Košice, Slovakia).